# Restricting the Flow of Acoustic Energy to a Single Direction in Aircraft and Missile Skin for Greater Heat Dissipation; Implications for Unidirectional Soundproofing Generally

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**Introduction**

As active electrolysis makes it possible to separate sufficient quantities of hydrogen from the water vapor in the atmosphere to provide continual thrust to hypersonic vehicles, creating a missile capable of generating its own fuel in real-time is not the only prerequisite for practical infinite-loiter hypersonic flight. Of chief concern at this time is securing the ability to render a vehicle's skin able withstand the extreme temperatures brought about by friction with the atmosphere at hypersonic velocities.

**Abstract**

Although atmospheric drag and friction are oftentimes thought of as being the same thing, they are not. Drag is a Newtonian counter-force associated with the inertia of the air (or other fluid) through which a vehicle may be attempting to transit. Friction, on the other hand, is the phenomenon through which an object's atoms interact directly with an external medium. Friction may lead to ablation, but for our purposes, the concern is non-ablative heat generation with its roots in acoustic effects of air molecules interacting with the skin of the missile or aircraft.

Each time an air molecule comes into contact with the body of a vehicle moving through the atmosphere, that contact leads to the generation of infinitesimal amounts of acoustic energy. At extreme velocities, such a large quantity of these quantum strikes of air against the skin of a missile results in the heating that we associate with friction. Sound waves moving at near-right angles with respect to one another can partially or entirely degenerate into pure heat. Think about how loud driving at 80MPH with the windows rolled down in your automobile can be and you begin to have some appreciation for just how much acoustic energy is dumped into the skin of a hypersonic missile.

Given that the skin of these aircraft and missiles are almost universally metallic, sound may echo nearly endlessly in all directions through the skin, resulting in a high proportion of that acoustic energy being converted into heat energy and heat energy already in place being trapped by the converging sound waves rather than allowed to flow through the material away from the zones of peak heating.

If sound could be made to flow in only a single direction through the skin of a hypersonic vehicle, the generated acoustic energy could be used to aid in the

dispersion of accumulated heat energy and could therefore keep the heating of the integument of the aircraft or missile beneath a specific maximum level.

A time-tested mechanism already exists for controlling the flow of fluids through a medium in a unidirectional fashion. The Tesla Valve is capable of, using nothing but elongated barriers placed throughout the medium at specific angles, permitting the flow of water through a pipe in only a single direction.

Rather than physical barriers placed in the midst of water, this basic concept may be adapted for our purposes by instead utilizing gaps in a metallic material of the same shape (but much smaller size; perhaps about 80 microns each) of the barriers in a Tesla Valve, which consist of an atmospheric vacuum. The fluid, in this case, is the sound moving through the metallic skin of the aircraft or missile.

As sound cannot move through a vacuum, it would tend to be reflected at the boundaries of these gaps. When the sound is moving in the direction that permits flow, it flows with relatively little resistance. In this case, the object is to permit sound to flow toward the rear of the aircraft or missile while not permitting reverberative energy from flowing from the rear of the aircraft toward the front for additional passes through the skin.

While this would cause rear sections of the aircraft or missile to become hotter than they otherwise would, it would keep the critical zones of peak heating substantially cooler.

Should frequency-normalizing prismatic skin of a crystalline composition be incorporated in some future vehicle (for the purpose of defeating missile defense,) IR radiational cooling would be aided by the presence of an optically transparent layer on the skin of the missile rather than the light-blocking radar-absorbent paint ordinarily utilized, a change that could provide some measure of additional cooling of the missile's skin.

What might be termed "broken chevrons" consisting of these vacuum gaps would begin a few millimeters beneath the surface of the skin, angled to draw sound into the inner skin at a shallow angle from the outer skin with the broken chevron patterns gradually shifting to be oriented to draw sound directly toward the rear of the vehicle.

**Conclusion**

Contingent upon the results of testing, this approach may yield prototypes capable of surviving sustained hypersonic flight. The effect of the expansion of the metal in the skin on the dimensions of the gaps would need to be accounted for and the most efficient set of dimensions and spacings would need to be identified through a testing process, with the thickness and composition of the skin as well as the variable velocity of the missile affecting the average pitch and amplitude of the acoustic energy and thereby rendering as variable the most efficient dimensions and spacing for such acoustic flow control features.